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Final Progress Report
NASA Grant NAG2-1177

Research conducted with the support of NASA Grant NAG2-1177 has been focused in the main on the development of fuzzy logic and soft computing methodologies and their applications to systems analysis and control, with emphasis on problem areas which are of relevance to NASA's missions.

The following report comprises two sections which relate, respectively, to contributions made by L. A. Zadeh and R. Yager.

L. A. Zadeh

Our earlier research on computing with words (CW) has led to a new direction in fuzzy logic which points to a major enlargement of the role of natural languages in information processing, decision analysis and control. This direction is based on the methdology of computing with words and embodies a new theory which is referred to as the computational theory of perceptions (CTP). An important feature of this theory is that it can be added to any existing theory -- especially to probability theory, decision analysis, and control -- and enhance the ability of the theory to deal with real-world problems in which the decision-relevant information is a mixture of measurements and perceptions.

The new direction is centered on an old concept -- the concept of a perception -- a concept which plays a central role in human cognition. The ability to reason with perceptions -- perceptions of time, distance, force, direction, shape, intent, likelihood, truth and other attributes of physical and mental objects -- underlies the remarkable human capability to perform a wide variety of physical and mental tasks without any measurements and any computations. Everyday examples of such tasks are parking a car, driving in city traffic, cooking a meal, playing golf and summarizing a story.

Perceptions are intrinsically imprecise. Imprecision of perceptions reflects the finite ability of sensory organs and ultimately, the brain, to resolve detail and store information. More concretely, perceptions are both fuzzy and granular, or, for short, f-granular. Perceptions are f-granular in the sense that (a) the boundaries of perceived classes are not sharply defined; and (b) the elements of classes are grouped into granules, with a granule being a clump of elements drawn together by indistinguishability, similarity, proximity or functionality. F-granularity of perceptions may be viewed as a human way of achieving data compression.

In large measure, scientific progress has been, and continues to be, driven by a quest to progress from perceptions to measurements. Pursuit of this aim has led to brilliant successes. But alongside the successes stand problems whose solutions are not in sight. Representative of such problems is the problem of automation of driving in city traffic. In this case, as in many others, what can ben done with ease by humans -- without any measurements and any computations -- is an intractable task for machines.

The point of departure in the computational theory of perceptions is the assumption that perceptions are described as propositions in a natural language, e.g., "Michelle is slim," "it is likely to rain tomorrow," "it is very unlikely that there will be a significant increase in the price of oil in the near future." In this perspective, natural languages may be viewed as systems for describing perceptions.

To be able to compute with perceptions it is necessary to have a means of representing their meaning in a way that lends itself to computation. Conventional approaches to meaning representation cannot serve this purpose because the intrinsic imprecision of perceptions puts them well beyond the expressive power of predicate logic and related systems. In the computational theory of perceptions, meaning representation is based on what is referred to as constraint-centered semantics of natural languages (CSNL).

A concept which plays a central role in CSNL is that of a generalized constraint. Conventional constraints are crisp and are expressed as $X \in C$, where X is a variable and C is a crisp set. In a generic form, a generalized unconditional constraint is expressed as X isr R, where X is the constrained variable; R is the constraining (fuzzy) relation which is called the generalized value of X; and isr, pronounces as ezar, is a variable copula in which the value of the discrete variable r defines the way in which R constrains X. Among the basic types of constraints are the following: equality constraints (r:=); possibilistic constraints (r:blank); veristic constraints (r:v); probabilistic constraints (r:p); random set constraints (r:rs); usuality constraints (r:u); and fuzzy graph constraints (r:fg).

In constraint-centered semantics, a proposition, p, is viewed as an answer to a question, q, which is implicit in p. The meanings of p and q are represented as generalized constraints, which play the roles of *canonical forms* of p and q, $CF(p)$ and $CF(q)$, respectively. $CF(p)$ is expressed as: X isr $?R$, read as "What is the generalized value of X?" Correspondingly, $CF(p)$ is expressed as: X isr R, read as "The generalized value of X isr R." The process of expressing p and q in their canonical forms plays a central role in constraint-centered semantics and is referred to as *explicitation*. Explicitation may be viewed as translation of p and q into expressions in GCL -- the Generalized Constraint Language.

In the computational theory of perceptions, representation of meaning is a preliminary to reasoning with perceptions -- a process which starts with a collection of perceptions which constitute the initial data set (IDS) and terminates in a proposition or a collection of propositions which play the role of an answer to a query, that is, the terminal data set (TDS). Canonical forms of propositions in IDS constitute the initial constraint set (ICS). The key part of the reasoning process is goal-directed propagation of generalized constraints from ICS to a terminal constraint set (TCS) which plays the role of the canonical form of TDS. The rules governing generalized constraint propagation in the computational theory of perceptions coincide with the roles of inference in fuzzy logic. The principal generic rules are: conjunctive rule; disjunctive rule; projective rule; surjective rule; inversive rule; compositional rule; and the extension principle. The generic rules are specialized by assigning specific values to the copula variable, r, in X isr R.

The principal aim of the computational theory of perceptions is the development of an automated capability to reason with perception-based information. Existing theories do not have this capability and rely instead on conversion of perceptions into measurements -- a process which in many cases is infeasible, unrealistic or counterproductive. In this perspective, addition of the machinery of the computational theory of perceptions to existing theories may eventually lead to theories which have a superior capability to deal with real-world problems and make it possible to conceive and design systems with a much higher MIQ (Machine IQ) than those we have today.

Partial list of publications

1. Toward a theory of fuzzy information granulation and its centrality in human reasoning and fuzzy logic, *Fuzzy Sests and Systems 90*, 111-127, 1997.

2. Applications of Fuzzy Logic: Toward High Machine Intelligence Quotient Systems, co-edited with M. Jamshidi, A. Titli and S. Boverie, Upper Saddle River NJ: Prentice Hall, 1997.

3. Some reflections on soft computing, granular computing and their roles in the conception, design and utilization of information/intelligent systems, *Soft Computing 2*, 23-25, 1998.

4. Maximizing sets and fuzzy Markoff algorithms, *IEEE Transactions on Systems, Man, and Cybernetics Part C 28*, 9-15, 1998.

5. From computing with numbers to computing with words -- from manipulation of measurements to manipulation of perceptions, *IEEE Transactions on Circuits and Systems 45*, 105-119, 1999.

6. Fuzzy logic, *The MIT Encyclopedia of the Cognitive Sciences*, edited by R.A. Wilson and F.C. Keil, Cambridge: The MIT Press, 335-336, 1999.

7. Information, Uncertainty and Fusion, co-edited with R. R. Yager and B. Bouchon-Meunier, Boston: Kluwer, 1999.

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Ronald R. Yager Contribution

One focus of our research was on the theory of approximate reasoning and the related concept of computing with words. Among our accomplishments in this area is the development of a general framework for veristic variables. Central to computing with words is the representation of knowledge by the association of a value with a variable and the idea of a generalized constraint. While possibilistic variables have emerged as the fundamental type of variables based on fuzzy sets there exists another class of variables which require the use of fuzzy sets to aid in their representation, these are variables which can have multiple solutions and have come to be called veristic variables. Examples of this are variables corresponding to languages a persons speaks and hobbies of interest. These can be of use in diagnosis problems where they enable the recognition of multiple faults. In our work in this area we have provided a basic framework for the translation of linguistic statements involving veristic variables into a formal framework that allows computer manipulation of this kind of information.

During this research we worked on a number of issues related to the use of fuzzy sets in information retrieval. One area in which we have concentrated is on the development of tools useful for the construction of complex queries in a way compatible with human description. Particularly noteworthy here is our use of ideas from fuzzy set theory to develop a new class of multi-attribute aggregation functions. This class, which is of a hierarchical type allows for an easy transition from human description in linguistic terms to a formal mathematical representation. Here a query can be initially described by high level concepts and then these concepts are defined in terms of simpler concepts until we reach a level of expression whose satisfaction is directly measurable from the documents. Fuzzy sets and linguistic quantifiers are used to help in the implementation of this process. In this framework each concept consists of three tuple; a measure of its importance, a subset of subconcepts and an agenda for combining its constituent subcomponents. The OWA operators are used to help implement the aggregation mechanism.

During this research we worked on a number of issues related to the use of fuzzy sets in recognition technology. We began the development, within the framework of fuzzy sets and possibility theory, of a scheme for object recognition which has a particular focus on handling problems that are common in application domains where the objects to be recognized (detected and identified) represent undesirable situations, referred to as crises. Crises develop over time and observations typically increase in number and precision as the crisis develops. While early detection of crises is desired, since it increases the possibility of an effective action, it is often at odds with precise recognition. The crisis recognition problem is central in several areas of decision support, such as target recognition and early warning systems. The problem is characterized by vague knowledge, and observations suffering from several kinds of imperfections, such as missing information, imprecision, uncertainty, unreliability of the source, and mutual, possible conflicting or reinforcing, observations of the same phenomena. The problem of handling possibly imperfect observations from multiple sources includes the problems of information fusion and multiple sensor data fusion. In our framework the different kinds of imperfection are handled in the framework of fuzzy sets and possibility theory.

We investigated a number of issues related to the problem of decision making under uncertainty. Here we have used the fuzzy measure to provide a general framework to represent uncertain information. With the use of the fuzzy measure we are able to represent various different types of uncertain information, probabilistic and possibilistic among others, in a unified framework. Once having represented our uncertainty in this framework we focused on the problem of comparing different courses of action. This required the development of appropriate valuation functions. We provided a specification of the formal properties expected of a valuation function. In order to obtain these valuation functions we used the Choquet integral. Using this approach we have developed a class of valuation functions appropriate for different types of uncertainty. We have looked at ways of including the decision makers attitude in the decision process. We are investigating the use of fuzzy systems modeling as a means of constructing decision functions. With this technology shall be able to allow a decision maker to express there decision making preferences in imprecise linguistic terms using prototypical situations. From these prototypical cases using the generalizing capacity of the fuzzy modeling technique we are extend our model to cover new cases.

We introduced a more general type of Ordered Weighted Averaging (OWA) operator called the Induced Qrdered Weighted Averaging (IOWA) Operator. These operators take as their argument pairs, called OWA pairs, in which one component is used to induce an ordering over the second components which are then aggregated. A number of different aggregation situations have been shown to be representable in this framework. A particularly notable use of this is in cases when we want mix numbers and words. With this new operator we are able to provide a context based on the words and the do the actual aggregation using the numbers. Another important application of this operator, which we are currently investigating, is that it allows you to learn models in which the weights assigned to the arguments are determined based upon the value of another variable.

PUBLICATIONS SUPPORTED IN FULL OR PART UNDER GRANT

- Bouchon-Meunier, B., Yager, R. R. and Zadeh, L. A., Information, Uncertainty, and Fusion, Kluwer Academic Publishers: Norwell, MA, 2000.
- Bouchon-Meunier, B., Yager, R. R. and Zadeh, L. A., Uncertainty in Intelligent and Information Systems, World Scientific Publishers: Singapore, (To Appear).
- Yager, R. R. and Rybalov, A., "Fusing lists retrieved from multiple information sources," in Frontiers in Soft Computing and Decision Sciences, edited by Medsker, L., AAAI Press: Menlo Park, CA, 62-70, 1998.
- Yager, R. R., "On the construction of hierarchical fuzzy systems models," IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews 28, 55-66, 1998.
- Larsen, H. L. and Yager, R. R., "An approach to an object recognition agent for monitoring Internet information sources for crisis detection," Proceedings Seventh International Conference on Information Processing and Management of Uncertainty in Knowledge- based Systems, Paris, 1496-1501, 1998.
- Yager, R. R. and Filev, D., "Operations for granular computing: mixing words and numbers," Proceedings of the FUZZ-IEEE World Congress on Computational Intelligence, Anchorage, 123-128, 1998.
- Dubois, D., Prade, H. and Yager, R. R., "Computation of intelligent fusion operations based on constrained fuzzy arithmetic," Proceedings of the FUZZ-IEEE, World Congress on Computational Intelligence, Anchorage, 767-772, 1998.
- Yager, R. R. and Pasi, G., "On the issue of document retrieval from multiple independent sources," Proceedings Seventh International Conference on Information Processing and Management of Uncertainty in Knowledge- based Systems, Paris, 1502-1509, 1998.
- Yager, R. R., "On the solution of simultaneous fuzzy models," Proceedings of the FUZZ-IEEE, World Congress on Computational Intelligence, Anchorage, 956-960, 1998.
- Pasi, G. and Yager, R. R., "An approach to compute default attribute values in fuzzy object oriented data models," Proceedings of the FUZZ-IEEE, World Congress on Computational Intelligence, Anchorage, 1326-1331, 1998.
- Yager, R. R., "Including importances in OWA aggregations using fuzzy systems modeling," IEEE Transactions on Fuzzy Systems 6, 286-294, 1998.
- Yager, R. R., "Mixed strategies and decision making under uncertainty," Proceedings of the 2nd International Workshop on Preferences and Decisions, Trento, 102-106, 1998.

• Grabisch, M., Orlovski, S. A. and Yager, R. R., "Fuzzy aggregation of numerical preferences," in Fuzzy Sets in Decision Analysis, Operations Research and Statistics, edited by Slowinski, R., Kluwer Academic Publishers: Norwell, MA, 31-68, 1998.

• Yager, R. R. and Rybalov, A., "Retrieving documents from multiple information sources," in New Trends in Fuzzy Systems, edited by Mancini, D., Squillante, M. and Ventre, A., World Scientific Publishers: Singapore, 3-22, 1998.

• Yager, R. R., "Fusion of ordinal information using weighted median aggregation," International Journal of Approximate Reasoning 18, 35-52, 1998.

• Yager, R. R., "Structures for prioritized fusion of fuzzy information," Information Sciences 108, 71-91, 1998.

• Yager, R. R., "New modes of OWA informatiom fusion," International Journal of Intelligent Systems 13, 661-681, 1998.

• Yager, R. R. and Filev, D. P., "Fuzzy rule based models and approximate reasoning," in Fuzzy Systems- Modeling and Control, edited by Nguyen, H. and Sugeno, M., Kluwer Academic Publisher: Norwell, MA, 91-133, 1998.

• Cutello, V. and Yager, R. R., "Fuzzy typical values and sets defined from statistical data," in Fuzzy Logic and Intelligent Technologies for Nuclear Science and Industry, edited by Ruan, D., Abderrahim, H. A., D'hondt, P. and Kerre, E. E., World Scientific: Singapore, 44-51, 1998.

• Yager, R. R., "On measures of specificity," in Computational Intelligence: Soft Computing and Fuzzy-Neuro Integration with Applications, edited by Kaynak, O., Zadeh, L. A., Turksen, B. and Rudas, I. J., Springer-Verlag: Berlin, 94-113, 1998.

• Yager, R. R. and Rybalov, A., "On the fusion of documents from multiple collection information retrieval systems," Journal for the American Society for Information Science 49, 1177-1184, 1998.

• Scerri, E. R., Kreinovich, V., Wojciehowski, P. and Yager, R. R., "Ordinal explanation of the periodic system of chemical elements," International Journal of Uncertainty, Fuzziness and Knowledge-based Systems 6, 387-401, 1998.

• Yager, R. R. and Rybalov, A., "Full reinforcement operators in aggregation techniques," IEEE Transactions on Systems, Man and Cybernetics 28, 757-769, 1998.

• Yager, R. R., "Characterizations of fuzzy set properties," in Handbook of Fuzzy Computation, edited by Ruspini, E., Bonissone, P. and Pedrycz, W., Oxford University Press: New York, B2.5:1-B2.5:8, 1998.

• Turksen, I. B., Kreinovich, V. and Yager, R. R., "A new class of fuzzy implications. Axioms of fuzzy implication revisited," Fuzzy Sets and Systems 100, 267-272, 1998.

• Yager, R. R., "Measures of information in generalized constraints," International Journal of Uncertainty, Fuzziness and Knowledge-based Systems 6, 519-532, 1998.

• Ribeiro, R., Zimmermann, H. J., Yager, R. R. and Kacprzyk, J., Soft Computing in Financial Engineering, Physica-Verlag: Heidelberg, 1999.

• Yager, R. R. and Lamata, M. T., "Decision making under uncertainty with nonnumeric payoffs," in Soft Computing in Financial Engineering, edited by Ribeiro, R., Zimmermann, H. J., Yager, R. R. and Kacprzyk, J., Physica-Verlag: Heidelberg, 21-38, 1999.

• Yager, R. R. and Filev, D. P., "Induced ordered weighted averaging operators," IEEE Transaction on Systems, Man and Cybernetics 29, 141-150, 1999.

• Detyniecki, M., Seyrat, C. and Yager, R. R., "Interacting with web video objects," Proceedings of the 18th Conference of the North American Fuzzy Information Processing Society (NAFIPS), New York, 914-917, 1999.

• Yager, R. R., "Measuring information in possibilistic logic," International Journal of Intelligent Systems 14, 475-500, 1999.

• Yager, R. R., "Fuzzy methods in E-commerce," Proceedings of the 18th Conference of the North American Fuzzy Information Processing Society (NAFIPS), New York, 5-11, 1999.

• Yager, R. R., "Fuzzy set methods for representing commonsense knowledge," Journal of Intelligent and Fuzzy Systems 7, 27-45, 1999 .

• Yager, R. R., "On the evaluation of uncertain courses of action," Technical Detyniecki, M., Bouchon-Meunier, B. and Yager, R. R., "Balance operator: a new vision on aggregation operators," Proceedings of EUROFUSE, Budapest Hungary, 241-246, 1999.

• Rasmussen, D. and Yager, R. R., "Finding fuzzy and gradual functional dependencies with summarySQL," Fuzzy Sets and Systems 106, 131-142, 1999.

• Yager, R. R., "On global requirements for implication operators in fuzzy modus ponens," Fuzzy Sets and Systems 106, 3-10, 1999.

• Yager, R. R., "Including decision attitude in probabilistic decision making," International Journal of Approximate Reasoning 21, 1-21, 1999.

• Yager, R. R., "Conflict resolution in the fusion of fuzzy knowledge via information maximization," International Journal of General Systems, (To Appear).

• Yager, R. R., "Simultaneous solution of fuzzy models: An application to economic equilibrium analysis," Fuzzy Sets and Systems, (To Appear).

• Yager, R. R. and Kelman, A., "An extension of the analytical hierarchy process using OWA operators," International Journal of Fuzzy and Intelligent Systems, (To Appear).

• Yager, R. R., "Fusion of multi-agent preferences orderings," Fuzzy Sets and Systems, (To Appear).

- Yager, R. R., "Approximate reasoning as a basis for computing with words," in Computing with Words in Information/Intelligent Systems 1, edited by Zadeh, L. A. and Kacprzyk, J., Springer-Verlag: Heidelberg, 50-77, 1999.
- Yager, R. R., "A game theoretic approach to decision making under uncertainty," International Journal of Intelligent Systems in Accounting, Finance and Management 8, 131-143, 1999.
- Pasi, G. and Yager, R. R., "Calculating attribute values using inheritance structures in fuzzy object oriented data models," IEEE Transactions on Systems, Man and Cybernetics: Part C, (To Appear).
- Yager, R. R., "Aggregation operations for fusing fuzzy information," in Softcomputing for Human Centered Machines, edited by Liu, Z. Q. and Miyamoto, S., Springer-Verlag: Berlin, (To Appear).
- Yager, R. R., "Fuzzy modeling for intelligent decision making under uncertainty," IEEE Transactions on Systems, Man and Cybernetics Part B: Cybernetics, (To Appear).
- Yager, R. R., "Constructing decision functions using fuzzy methods," Proceedings Fifth International Conference of the Decision Sciences Institute, Athens, 1464-1467, 1999.
- Yager, R. R. and Kreinovich, V., "On how to merge sorted lists coming from different web search tools," Soft Computing Research Journal, (To Appear).
- Yager, R. R., "Decision making with fuzzy probability assessments," IEEE Transactions on Fuzzy Systems 7, 462-467, 1999.
- Larsen, H. L. and Yager, R. R., "A framework for fuzzy recognition technology," IEEE Transactions on Systems Man and Cybernetics, (To Appear).
- Yager, R. R., "Decision making under uncertainty with ordinal information," International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, (To Appear).
- Larsen, H. L. and Yager, R. R., "Fuzzy object recognition for crisis in uncertain environments," in Information Uncertainty and Fusion, edited by Bouchon-Meunier, B., Yager, R. R. and Zadeh, L. A., Kluwer Publishers: Norwell, MA, (To Appear).
- Yager, R. R., "A class of fuzzy measures generated from a Dempster-Shafer Belief Structure," International Journal of Intelligent Systems, (To Appear).
- Yager, R. R. and Filev, D., "On ranking fuzzy numbers using valuations," International Journal of Intelligent Systems, (To Appear).
- Yager, R. R., "A framework for linguistic and hierarchical queries in document retrieval," in Soft Computing in Information Retrieval: Techniques and Applications, edited by Crestani, F. and Pasi, G., Physica Verlag: Heidelberg, (To Appear).
- Yager, R. R., "Veristic variables," IEEE Transactions on Systems, Man and Cybernetics

Part B: Cybernetics, (To Appear).

• Yager, R. R., "Nonmonotonic OWA operators," Soft Computing, (To Appear).

• Yager, R. R. and Kreinovich, V., "Decision making under interval probabilities," International Journal of Approximate Reasoning, (To Appear).

• Yager, R. R., "On the instantiation of possibility distributions," Fuzzy Sets and Systems, (To Appear).

• Yager, R. R., "Modeling uncertainty using partial information," Information Sciences, (To Appear).

• Yager, R. R. and Kreinovich, V., "Fair division under interval uncertainty," Technical Report# MII-1820 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1998. (In Review).

• Yager, R. R., "Interval valued Dempster-Shafer belief structures," Technical Report# MII-1906 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 (In Review).

• Dubois, D., Prade, H. and Yager, R. R., "Merging fuzzy information," in Fuzzy Sets in Approximate Reasoning and Information Systems, edited by Bezdek, J. C., Dubois, D. and Prade, H., Kluwer Academic Publishers: Norwell, MA, 335-401, 1999.

• Yager, R. R., "Approximate reasoning and conflict resolution," Technical Report# MII-1904 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 (In Review).

• Detyniecki, M., Yager, R. R. and Bouchon-Meunier, B., "Specifying t-norms based on the value of T(1/2, 1/2)," Technical Report# MII-1912 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 (In Review).

• Detyniecki, M. and Yager, R. R., "A note on ranking fuzzy numbers using alpha-weighted valuations," Technical Report# MII-1913 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 (In Review).

• Yager, R. R., "Ordinal decision making with a notion of acceptable: denoted ordinal scales," Technical Report# MII-1914 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 (In Review).

•Yager, R. R., "Uninorms in fuzzy systems modeling," Fuzzy Sets and Systems, (To Appear).

• Yager, R. R., "Hierarchical aggregation functions generated from belief structures," Technical Report# MII-1915 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 .(In Review)

• Yager, R. R., "On the entropy of fuzzy measures," Technical Report# MII-1917 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 .(In Review)

• Yager, R. R., "A hierarchical document retrieval language," Technical Report# MII-1920

Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 • Yager, R. R., "Criteria aggregations functions using fuzzy measures and the choquet integral," Technical Report# MII-1919 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999 .(In Review)

• Yager, R. R., "On the evaluation of uncertain courses of action," Technical Report# MII-1924 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999. (In Review)

• Yager, R. R., "Decision making under various types of uncertainty," Technical Report# MII-1907 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1997.

Yager, R. R., "Querying video using fuzzy temporal concepts," Proceedings of the North American Fuzzy Information Processing Society Conference, Pensacola, 247-250, 1998.

• Yager, R. R., "Constraint satisfaction using soft quantifiers," Technical Report# MII-2002 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999.

• Yager, R. R., "Determining equivalent values for possibilistic variables," Technical Report# MII-2001 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999.

• Yager, R. R. and Kacprzyk, J., "Linguistic data summaries: a perspective," Proceedings of the Eight International Fuzzy Systems Association World Congress, Taiwan Vol 1, 44-48, 1999.

• Yager, R. R., "On the calculation of a possibilistic equivalent value," Technical Report# MII-2000F Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999.

• Yager, R. R., "On the representation of veristic variables," Technical Report# MII-2005 Machine Intelligence Institute, Iona College, New Rochelle, NY, 1999.

• Engemann, K. J., Miller, H. E. and Yager, R. R., "Evaluating risk and transnational decision support systems using interval probabilities," Proceedings of INTERSYMP, Eleventh International Conference on Systems Research, Informatics and Cybernetics, (To Appear).

• Engemann, K. J., Miller, H. E. and Yager, R. R., "Scenario-based analysis in services: models incorporating the decision maker's disposition," Proceedings of the 1999 International Conference of Service Operations Management Association, (To Appear).

• Yager, R. R., "Maximizing the information obtained from data fusion," Technical Report# MII-2007 Machine Intelligence Institute, Iona College, New Rochelle, NY,1999.

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